Amendments to the Claims

The following Listing of Claims replaces all prior versions, and listings, of claims in the application.

Listing of Claims:

Claim 1 (currently amended): An error diffusion halftoning method comprising:

modifying a current input to produce a modified input, wherein the modifying comprises incorporating past quantization errors into the current input;

~~using a quantizer having~~quantizing the modified~~an~~ input ~~and~~to produce an output; and

processing the output through a data processing path having~~using a sytem having~~ a bandpass transfer characteristic, wherein the processing comprises deriving an error value from the modified input and the output and diffusing the error value into future inputs~~to modify the quantizer input without feeding the quantizer output directly into the quantizer input~~.

Claim 2 (currently amended): The method of claim 1, wherein the processing comprises shaping quantization noise in the output in accordance with the bandpass transfer characteristic~~if the quantizer was replaced by a source for injecting uncorrelated noise and no input was present to the system, the system would shift the noise injection from a high frequency range to a middle frequency range~~.

Claim 3 (currently amended): The method of claim 1, wherein~~using the system includes at least one filter to provide~~ the bandpass transfer characteristic has a response that corresponds to a bandpass transfer function B(z) defined by

$$B(z) = \frac{(1-\alpha)H(z) + \alpha H(z)K(z)}{1 - \alpha H(z) + \alpha H(z)K(z)}$$

where H(z) and K(z) are transfer functions~~;~~, and α is a scalar that controls pixel clustering.

Claim 4 (currently amended): The method of claim 3, wherein coefficients of the transfer functions H(z) and K(z) sum to unity at dc, ~~whereby bandpass shaping behavior of~~and the bandpass transfer function ~~is~~has a mean-preserving behavior.

Claim 5 (currently amended): The method of claim 1, wherein~~using~~ the~~system~~ processing comprises low-pass filtering the~~quantizer~~ output with a first linear weighting filter, generating ~~an~~a second error~~signal~~ value~~from~~ based on the filtered output~~single~~ and~~a quantizer~~ the modified input~~signal;~~, and low pass filtering the second error~~signal~~ value with a second linear weighting filter to produce the first error value.

Claim 6 (currently amended): The method of claim 1, wherein~~using the system includes generating an error in response to the quantizer input and output; and applying an infinite impulse response filter to~~ the processing comprises bandpass filtering the error~~signal~~ value into future inputs~~, an output of the infinite impulse response filter used to modify the quantizer input~~.

Claim 7 (currently amended): Apparatus for performing error diffusion halftoning, the apparatus comprising:

a modifier operable to modify a current input to produce a modified input, wherein the modifier is operable to incorporate past quantization errors into the current input;

a quantizer operable to quantize the modified input and to produce an output~~having an input and an output~~; and

a processing path having a bandpass transfer characteristic and being operable to derive an error value from the modified input and the output and to diffuse the error value into future inputs~~filtering means having an effective bandpass transfer function for modifying the quantizer input without feeding the quantizer output directly into the quantizer input~~.

Claim 8 (currently amended): The apparatus of claim 7, wherein the bandpass transfer characteristic has a response that corresponds to a bandpass transfer function B(z) ~~is~~defined by

$$B(z) = \frac{(1-\alpha)H(z) + \alpha H(z)K(z)}{1 - \alpha H(z) + \alpha H(z)K(z)}$$

where H(z) and K(z) are transfer functions, and α is a scalar that controls pixel clustering.

Claim 9 (currently amended): Apparatus for performing error diffusion halftoning, the apparatus comprising a processor ~~for performing quantization, and using an error signal filtered with a bandpass characteristic to modify the quantizer input without directly feeding a result of the quantization to an input of the quantization~~operable to perform operations comprising:

modifying a current input to produce a modified input, wherein the modifying comprises incorporating past quantization errors into the current input;

quantizing the modified input to produce an output; and

processing the output through a data processing path having a bandpass transfer characteristic, wherein the processing comprises deriving an error value from the modified input and the output and diffusing the error value into future inputs.

Claim 10 (currently amended): The apparatus of claim 9, wherein ~~the processor uses~~ the bandpass transfer characteristic has a response that corresponds to a bandpass transfer function B(z) ~~to produce the filtered error signal, where~~defined by

$$B(z) = \frac{(1-\alpha)H(z) + \alpha H(z)K(z)}{1 - \alpha H(z) + \alpha H(z)K(z)}$$

where H(z) and K(z) are transfer functions, and where α is a scalar that controls pixel clustering.

Claim 11 (currently amended): The apparatus of claim 10, wherein coefficients of the transfer functions H(z) and K(z) sum to unity at dc, ~~whereby~~and the bandpass transfer function has a mean-preserving behavior.

Claim 12 (currently amended): The apparatus of claim 9, wherein the ~~filtered error signal is produced by~~processor is operable to performing operations comprising low-pass filtering the ~~result of the quantization~~output with a first linear weighting filter, generating ~~an~~a second error ~~signal from~~value based on the filtered output ~~signal~~value and the ~~quantization~~modified input~~;~~, and low-pass filtering the second error ~~signal~~value with a second linear weighting filter to produce the first error value.

Claim 13 (currently amended): The apparatus of claim 9, wherein the processor is operable to bandpass filter the error value into future inputs~~filtered error signal is produced by generating an error in response to the quantization input and the result of the quantization; and applying an infinite impulse response filter to the error signal, an output of the infinite impulse response filter used to modify the quantization input~~.

Claim 14 (currently amended): The apparatus of claim 9, wherein in the processing operation the processor ~~generating the filtered error signal with a system wherein if the quantizer was replaced by a source for injecting uncorrelated noise and no input was present to the system, the system would shift the noise injection~~is operable to shape quantization noise in the output in accordance with the bandpass transfer characteristic~~from a high frequency range to a middle frequency range~~.

Claim 15 (original): An article for a processor, the article comprising memory encoded with data for instructing the processor to perform error diffusion halftoning, the error diffusion halftoning including performing quantization, and filtering with an effective bandpass characteristic without using an output of the quantization to directly influence an input of the quantization.

Claim 16 (original): The article of claim 15, wherein the filtered error signal is used to modify the quantization input.

Claim 17 (original): The article of claim 15, wherein the filtering is based on the noise transfer function

$$B(z) = \frac{(1-\alpha)H(z) + \alpha H(z)K(z)}{1 - \alpha H(z) + \alpha H(z)K(z)}$$

where H(z) and K(z) are transfer functions; and α is a scalar that controls pixel clustering.

Claim 18 (original): The article of claim 17, wherein coefficients of the transfer functions H(z) and K(z) sum to unity at dc.

Claim 19 (original): The article of claim 15, wherein using the filtering includes low pass filtering the quantization output with a first linear weighting filter, generating an error signal from the filtered output signal and the quantization input; and low pass filtering the error signal with a second linear weighting filter.

Claim 20 (original): The article of claim 15, wherein the filtering includes generating a n error from the quantization input and output; and applying an infinite impulse response filter to the error signal, an output of the infinite impulse response filter used to modify the quantization input.

Claim 21 (original): A printer comprising:

a print engine; and

a processor for performing error diffusion halftoning, the halftoning including performing quantization, and using an error signal filtered with an effective bandpass characteristic to influence the quantization without using a result of the quantization to directly influence an input of the quantization, an output of the quantization supplied to the print engine.

Claim 22 (new): The method of claim 1, wherein

the processing comprises

modifying the output to produce a modified output, wherein the modifying of the output comprises filtering past errors in accordance with a first low-pass filter transfer function and incorporating into the modified output the past errors filtered in accordance with the first low-pass filter transfer function, and

subtracting the modified input from the modified output to produce a second error value

filtering the second error value in accordance with a second low-pass filter transfer function to produce the first error value; and

the modifying comprises incorporating into the current input past error values filtered in accordance with the second low-pass filter transfer function to produce the modified input.

Claim 23 (new): The method of claim 1, wherein

the modifying comprises incorporating into the current input the past quantization errors filtered in accordance with a bandpass filter transfer function to produce the modified input, and

subtracting the modified input from the output to produce the error value.

Claim 24 (new): The article of claim 15, wherein the article stores processor-readable instructions causing the processor to perform operations comprising:

modifying a current input to produce a modified input, wherein the modifying comprises incorporating past quantization errors into the current input;

quantizing the modified input to produce an output; and

processing the output through a data processing path having a bandpass transfer characteristic, wherein the processing comprises deriving an error value from the modified input and the output and diffusing the error value into future inputs.

Claim 25 (new): The printer of claim 21, wherein the processor is operable to perform operations comprising:

modifying a current input to produce a modified input, wherein the modifying comprises incorporating past quantization errors into the current input;

quantizing the modified input to produce an output; and

processing the output through a data processing path having a bandpass transfer characteristic, wherein the processing comprises deriving an error value from the modified input and the output and diffusing the error value into future inputs.